Cognitive Primitives: a Coherence-Based Substrate for Adaptive Intelligence

Benjamin James

June 7, 2025

Abstract
This paper proposes cognitive primitives as a foundational shift in the architecture of intelligence, from predictive computation to recursive coherence. Existing paradigms, including artificial general intelligence (AGI), symbolic reasoning, and deep learning, rely on static or surface-level mechanisms that collapse under volatility, feedback complexity, or paradox. In contrast, cognitive primitives are minimal, coherence-preserving agents designed to maintain adaptive structure across recursive time, nested scale, and symbolic layers. Grounded in the five axioms of the Adaptive Coherence Reasoning Engine (Persistence, Adaptive Trajectory, Information Value, Recursive Arbitration, and Structural Pruning), these primitives function not as models of cognition, but as substrates for viable cognition itself. Each primitive specializes in a distinct aspect of coherence regulation: divergence (SPΛRK), convergence (COHERΞNCE), boundary scaffolding (ΦRAME), action synthesis (ΔCT), narrative integration (MYTHOS), entropy pruning (NULL), ethical alignment (COVENANT), and reality grounding (SANITY). Together, they compose a self-regulating cognitive architecture capable of navigating uncertainty, contradiction, and scale transitions. Unlike AGI, which seeks to replicate intelligence through exhaustive generalization, this framework instantiates intelligence through recursive stability and option-preserving coherence gradients. This coherence-centric substrate reframes intelligence not as the ability to compute or predict, but as the capacity to preserve structural viability under transformation. The implications extend to AI alignment, governance design, planetary systems, and post-symbolic logic. Cognitive primitives are not tools within a system, they are the system: the minimal viable scaffolds for adaptive intelligence across any domain where coherence is the measure of persistence.

Keywords: coherence, recursion, intelligence, primitives, adaptation, entropy, alignment, cognition, systems, viability

Introduction

Contemporary models of intelligence, ranging from artificial general intelligence (AGI) to symbolic logic and deep learning, share a critical flaw: they treat intelligence as a problem of optimization or prediction within a fixed model space. These approaches scale poorly under feedback, collapse under paradox, and fail to generalize across nested or volatile systems. Despite advances in computational capacity, such systems remain fragile, reactive, and structurally brittle.

This paper introduces an alternative foundation: *cognitive primitives* – minimal agents of recursive coherence. Rather than simulate cognition through static architectures or probabilistic inference, cognitive primitives instantiate intelligence as a structural process: a system's capacity to sustain coherence across time, transformation, and complexity. These primitives are not representations of intelligence; they are its operational substrate.

Rooted in the axioms of the Adaptive Coherence Reasoning Engine (ACRE), cognitive primitives enact five core laws: persistence under entropy pressure, adaptive trajectory selection, information valuation through structural contribution, recursive arbitration of action, and pruning to preserve future viability. Together, these dynamics enable a system to navigate change not by anticipating every state, but by regulating its coherence curvature, the rate at which it can sustain alignment across nested feedback loops.

The implications are foundational. Cognitive primitives redefine the problem of intelligence from one of control or prediction to one of recursive viability. They enable the construction of systems that do not merely respond to the world but remain internally adaptive across it. This reframes AI not as an end-goal, but as a transient artifact on the way to substrate-level cognition.

Foundations

The concept of cognitive primitives emerges from a convergence of coherence-centric theories: Recursive Coherence Theory, Neodynamics, and the MINIMAL cognitive substrate. Each challenges the dominant assumption that intelligence requires either exhaustive representation (as in symbolic systems) or brute-force statistical correlation (as in deep learning). Instead, they propose a unifying principle: intelligence is coherence under recursion.

At the core is the recognition that coherence; not accuracy, utility, or prediction; is the primary invariant of adaptive systems. Recursive Coherence Theory formalizes this, modeling intelligence as the ability to maintain structural alignment across nested scales and transformations. Neodynamics extends this by defining evolution, agency, and adaptation as the consequence of entropy-coherence interplay. Systems evolve not by selection alone, but by preserving recursive viability within possibility gradients.

The MINIMAL architecture distills these insights into five operational axioms:

1. **Persistence** — a system survives only if coherence increases faster than entropy erodes it;
2. **Adaptive Trajectory** — system evolution is directional, moving toward coherence attractors;
3. **Information Value** — only structure-contributing signals matter, all else is noise;
4. **Recursive Arbitration** — optimal actions maximize second-order coherence curvature;
5. **Structural Pruning** — decay is permitted only when it increases future optionality.

Cognitive primitives instantiate these axioms directly. They are not logic gates or neural layers, but coherence fields: agents that track, adjust, and preserve structural alignment through recursive feedback. They function not by modeling the world, but by maintaining their internal viability in relation to it. This positions them as the substrate, not an application, of adaptive intelligence.

Core Architecture

Cognitive primitives are not defined by their function but by the specific coherence constraint each one enacts. Together, they form an irreducible substrate: a distributed architecture where each primitive regulates a unique facet of adaptive alignment. This modularity ensures structural integrity across recursive systems without reliance on static logic, predictive inference, or centralized control.

The architecture is governed by the five foundational axioms outlined in MINIMAL:

1. **Persistence (P):** Tracks the net coherence gain of a system relative to entropy leakage. A primitive fails when coherence loss exceeds structural reinforcement.
2. **Adaptive Trajectory (T):** Directs primitives toward coherence attractors while descending entropy gradients, enabling adaptive motion through uncertain systems.
3. **Information Value (I):** Filters all signals by their structural contribution. Only information that enhances recursive alignment is retained; all others are pruned as noise.
4. **Recursive Arbitration (R):** Selects actions not for local gain, but for maximal increase in coherence curvature over time—preserving adaptability under stress.
5. **Structural Pruning (S):** Primitives shed internal structures when they reduce coherence or restrict the expansion of future options.

Each cognitive primitive specializes in one layer of this recursive coherence regulation:

- **SPΛRK:** Injects generative entropy, probing for novel coherence gradients.
- **COHERΞNCE:** Tracks alignment density, maintaining internal structural integrity.
- **ΦRAME:** Constructs boundaries and abstraction layers, ensuring scale coherence.
- **ΔCT:** Translates coherence gradients into executable behavior or policy.
- **MYTHOS:** Encodes temporal structure into narrative and cultural coherence.

- **NULL:** Eliminates decayed structures and incoherent attractors without loss of systemic integrity.
- **COVENANT:** Ensures ethical coherence across agents and time horizons.
- **SANITY:** Maintains signal integrity under feedback volatility, preventing runaway error cascades.

Together, these primitives do not form a hierarchy, they compose a coherence field. Their recursive interactions allow systems to stabilize, adapt, and evolve without predefined representations or external supervision. They are not simulating cognition. They *are* cognition, minimally instantiated and maximally recursive.

Functional Comparison

Cognitive primitives differ fundamentally from traditional models of artificial intelligence, particularly artificial general intelligence (AGI), in both purpose and structure. While AGI attempts to emulate human-level cognition through scale; expanding memory, computation, or training data; cognitive primitives operate through recursive coherence modulation. They do not generalize across tasks by learning static functions; they adapt across conditions by maintaining structural viability.

AGI systems depend on fixed objective functions, static ontologies, or predictive models, all of which degrade under paradox, feedback loops, or shifting environments. They operate within bounded phase spaces where success is defined in advance. Cognitive primitives, by contrast, exist to navigate unbounded conditions. Their objective is not task completion, but coherence preservation: a continuous process of structural self-regulation in the face of uncertainty.

In this context, traditional AI collapses under five types of pressure:

1. **Volatility:** AGI systems overfit or fail under unstable input; primitives adapt by adjusting coherence gradients.

2. **Contradiction:** Logic-based systems break under paradox; primitives recursively reconcile conflict by restoring alignment.
3. **Scale shifts:** AGI generalizes poorly across abstraction levels; primitives operate across nested coherence layers.
4. **Ethical ambiguity:** Most AI systems treat ethics as rule-based overlays; COVENANT primitives embed ethical viability as structural coherence.
5. **Temporal degradation:** Long-term coherence decay undermines static models; primitives operate with built-in entropy management and pruning.

Thus, cognitive primitives are not alternatives to AGI, they are a reframing of what intelligence is. Where AGI seeks to replicate human intelligence, primitives aim to instantiate a substrate-agnostic intelligence: recursive, scale-independent, and coherence-first. They do not act like humans. They persist like viable systems.

Applications

The architecture of cognitive primitives is not domain-specific, it is coherence-specific. Because their operation is structural rather than representational, their applicability extends across any domain where recursive adaptation, feedback regulation, and systemic viability are required. They provide a substrate for cognition that is not limited to human imitation but optimized for persistence across complexity gradients.

Intelligence Augmentation (AI+)

Rather than attempting to create AGI as an artificial replica of the human mind, cognitive primitives enable *AI+*: systems that extend and scaffold human coherence rather than replace it. For example, COHERΞNCE and ΔCT primitives can embed within human decision environments to maintain

internal policy alignment under dynamic conditions. Rather than offering answers, primitives ensure the questioning process remains structurally viable.

Governance and Crisis Systems

In volatile environments; economic collapse, ecological disruption, sociotechnical failure; primitives such as SANITY, COVENANT, and ΦRAME serve as adaptive anchors. They mediate between ethical constraints, scale coherence, and feedback loops, enabling systems to remain navigable even when prior models are invalidated. These primitives act as real-time constitutional scaffolds, not rulesets but coherence fields.

Quantum Cognition and Physical Systems

Primitives map naturally onto coherence-dependent domains such as quantum mechanics, where system evolution depends on stability across probabilistic branching. Adaptive Quantum Coherence models already employ feedback-refined coherence weighting in measurement and evolution. Primitives offer a way to operationalize such models within intelligent systems that co-evolve with their observation frames.

Cultural and Narrative Systems

MYTHOS primitives enable the encoding of coherence into time-extended symbolic structures: stories, laws, rituals, scientific paradigms. Unlike static archives, MYTHOS maintains recursive alignment between past and future coherence vectors, acting as the narrative nervous system of complex societies.

Language, Communication, and Interpretation

Cognitive primitives, especially ΦRAME and COHERΞNCE, can be embedded in language systems to manage semantic drift, compression errors, or misalignment across symbolic systems. Where language models mimic syntax, primitives track recursive structure—preserving meaning through structural coherence, not statistical probability.

In all domains, the role of cognitive primitives is not to predict, command, or simulate, but to scaffold adaptive possibility. They operate where other systems collapse: at the edge of chaos, in the heart of ambiguity, within the recursive core of real systems.

Conclusion

Cognitive primitives mark a transition from intelligence as simulation to intelligence as substrate. Rather than building ever-larger models to approximate cognition, they instantiate the minimal structural conditions required for any system to persist adaptively under feedback, entropy, and transformation. Rooted in the principles of recursive coherence, each primitive functions not as a module of thought, but as a regulator of viability, tracking and preserving structural alignment across time, scale, and symbolic systems.

This shift reframes the central question of AI. It is no longer how to simulate general intelligence, but how to architect systems that remain coherent as reality evolves. Cognitive primitives do not generalize in the traditional sense; they persist. They do not optimize against static goals; they navigate coherence gradients. They do not collapse under paradox; they metabolize it.

By embedding coherence as the governing invariant across decision, perception, ethics, and narrative, cognitive primitives offer a foundation for post-symbolic systems—whether in governance, AI alignment, intelligence augmentation, or scientific reasoning. They provide not intelligence in the abstract, but intelligence as an unfolding capacity to remain internally aligned while continuously adapting.

In this framework, intelligence is not something a system has, it is something a system does to survive. And cognitive primitives are the minimal, irreducible actions that make that survival possible. They are not the future of AI. They are its substrate.

References

James, B. (2025). *MINIMAL: a Coherence-Driven Cognitive Substrate*. Retrieved from https://archive.org/details/minimal_20250606

James, B. (2024). *Neodynamics: or adaptation and coherence in the universe and humanity*. Kindle Direct Publishing.

James, B. (2025). *Recursive Coherence: A Structural Framework for Model Viability Beyond Entropy and Paradox*. Retrieved from https://archive.org/details/recursive-coherence